‘Buildability’ in the Digital Age

Subjects: Construction & Building Technology | Others

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Since the emergence of the concept of “buildability” in 1983, numerous studies have focused on improving project performance through buildability. Initially, the buildability discourse was based on narrow definitions and focused on aspects that could improve construction performance.

Keywords: buildability ; constructability ; key constructs ; technology

1. Introduction

The construction industry plays a key role in a country’s economy [1], therefore, improving performance in the construction industry is vital. A construction project is commonly acknowledged as successful when the aim of the project is achieved in terms of its predetermined objectives, including completing the project on time, within budget, and to the required quality standard [2][3]. However, in most construction projects, severe time and cost overruns [4][5] and poor quality [6] have become a common phenomenon. For example, approximately 86% of construction projects experience cost overruns [7], 70% experience time overruns [8], and 10% of project materials end up as waste material [9] resulting in negative impacts on quality.

Past research proved that buildability and its further improvement could contribute to early completion of projects, savings in project costs, enhanced quality, improved safety performance, and a higher rate of productivity [10], and studies on buildability and its incorporation into construction projects therefore became popular.

Since the first emergence of the buildability concept in 1983, numerous studies have been carried out to further investigate how it could be integrated to minimize the issues that directly affect construction project time, cost, and quality. As a result, various researchers have developed rules, attributes, principles, concepts, and guidelines to incorporate buildability into construction projects to enhance construction project performance. For example, various industry research institutes have made large contributions to the buildability context. Among them, the Construction Industry Research and Information Association (CIRIA) and the Construction Industry Institute (CII) in the United States have provided guidelines for improving the buildability of building designs through several studies [11][12][13][14]. Similarly, the Construction Industry Institute Australia (CIIA) has introduced concepts that can improve buildability during the design stage [13]. Another study conducted by [15] suggested 23 buildability concepts that were popular at the time and were referred to by many subsequent researchers. Adding to this [16] introduced a concise mode of practice of buildability concepts, dividing the above 23 concepts into three phases—the initiation phase, execution phase, and delivery phase. Giving an overview of past buildability studies, ref. [17] showed that studies published between 1987 and 2020 can be categorized into three types, namely, (1) buildability principles, (2) impact of buildability, and (3) buildability assessment systems.

A key feature of the previous studies is that their main focus is on the early stages of construction projects. Nevertheless, the study conducted by [15] has suggested additional concepts to foster buildability during the field operations phase as well. These additional concepts were mainly focused on innovation in construction methodologies and material usage rather than knowledge extraction and integration across a broader spectrum to achieve goals. Agreeing with this, ref. [16] stated that past buildability studies have only promoted buildability at a theoretical level rather than developing practical applications for better deliverables throughout the entire process to satisfy project objectives. This is because exploration of the buildability concept through its key constructs has been slow or absent over three decades [18] although the construction industry has continuously evolved when faced with aspects such as modern technologies and various societal goals.

This is further evidenced by the fact that even recent studies in this area refer to the initial definitions that emerged in the 1980s, where buildability is referred to as “ease of construction” and “integration of knowledge and experience”. These definitions were developed over 40 years ago to provide a holistic perspective at that time and to improve construction project performance. Thus, they have not been deconstructed to a level that can be considered for its practical integration.

Hence, there are still issues with productivity and the achievement of overall goals due to a lack of understanding of buildability within the emerging cultural discourse. Confining buildability integration to the design stage alone is further evidence of this. Although various buildability studies have discussed practices, appraisal systems, attributes, principles, and concepts, there is little consideration given to the buildability concept through all stages of procurement. Furthermore, the discourse of buildability warrants investigation in order to understand how the basic tenets of buildability have evolved in practice over the last 30 years. Thus, the need for a renewed discourse of buildability within emerging changes in the sector is urgent so that its integration to improve performance can begin.

2. Constructability and Buildability

The review of the literature indicates that the term “constructability” has historically been used interchangeably with buildability [19][20][21][22]. Ref. [23] stated that these two terms refer to similar concepts except in some instances where the term “constructability” had been used to explain the broader management implications of construction projects. According to the CII and CIIA, the key components of constructability include the application of construction knowledge at different work stages to achieve the overall project objectives, which is similar to the concept of buildability. Hence, some researchers argue that constructability and buildability are two identical concepts used in different parts of the world [19][20][21][22][24]. The Building Construction Authority (BCA) in Singapore, which has pioneered buildability research, stated in their latest publication that “buildability” is the responsibility of the professional team and “constructability” is the responsibility of the builder [25]. Therefore, although there is no clear demarcation between these two terms, most researchers agree that both terms carry similar meanings for the enhancement of construction project performance [26]. Hence, the term “buildability” is used here to encompass both “constructability” and “buildability” terms.

3. Evolution of Buildability

Buildability deals with integrating knowledge and expertise at the right time through the most appropriate source. Although the term “buildability” had not been framed until the early 1980s, concerns about the buildability concept can be traced back to the early 1960s. For instance, studies conducted from 1960 to 1970 indicated that the lack of integration of knowledge and experience within the framework of design and construction was the origin of many complex problems [27]. Owing to this, industry reports by Sir Harold Emmerson in 1962 and the Banwell Committee in 1964 extensively discussed the consequences of poor knowledge integration such as design and construction coordination issues, poor preparation of drawings and specifications, and the inadequate level of communication between the key stakeholders. Among these, ref. [28] extensively criticized the lack of cohesion in the industry and suggested improving “knowledge sharing between the designers and contractors” to minimize the issues. This can be identified as the earliest instance at which buildability was first cited. Later, ref. [29] introduced an “integrated-team” concept consisting of “multi-skilled, multi-functional” professionals, which could be identified as a means of addressing “buildability”, although it was not coined as a terminology. **Figure 1** is a graphical illustration of the evolution of the buildability concept within major construction territories.

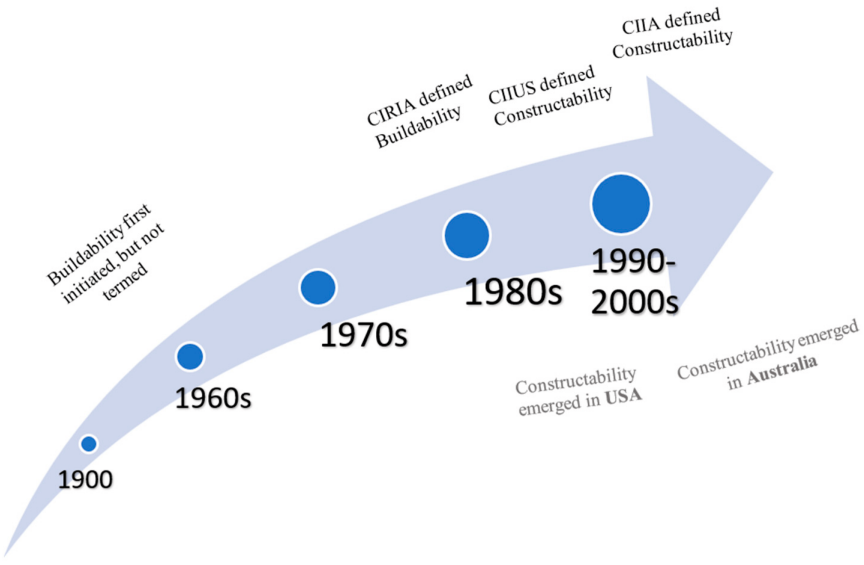

Figure 1. Evolution of the buildability concept within major construction territories.

CIRIA in 1983 first defined buildability as “the extent to which the design of a building facilitates ease of construction, subject to the overall requirements for the completed building”. This definition was criticized for its narrowness in scope as it was confined to the design process [23], although buildability has impacts throughout the various work stages of a construction project and hence on the accomplishment of the ultimate project goals [14]. Since then, numerous studies have been conducted to strive for better project performance by improving buildability. Accordingly, numerous researchers have interpreted buildability based on their conceptual assumptions. For example, ref. [30] stated that buildability is “design and detailing which recognize the assembly process in achieving the desired result safely and at least cost to the client”. Elaborating on this further, ref. [31] presented a new definition: “the ability to construct a building efficiently, economically and to agreed quality levels from its constituent materials, components and sub-assemblies”. Ferguson’s definition emphasized the optimum management and structuring of project activities and building processes to achieve project goals. Adding to them, ref. [32] stated that buildability is “a philosophy, which recognizes and addresses the problems of the assembly process in achieving the construction of the design, safely as well as without resorting to standardization or project-level simplification”. An extended clarity for buildability was introduced by CIIA, deviating from its traditional focus on “lack of knowledge”, stating that buildability is about “lack of management of information” rather than “lack of information” [13]. BCA in Singapore, who reflected on the influence of buildability on productivity, defined buildability as “the extent to which the design of a building facilitates ease of construction, as well as the extent to which the adoption of construction techniques and processes affects the productivity level of building works” [25].

4. Key Constructs of Buildability

A previous study considering 11 definitions of the terms “buildability” and “constructability” that emerged over four decades (1983–2022) revealed that this concept has not evolved much over time [18]. Agreeing with this, numerous researchers confirmed that the most widely accepted and published definition was the one that CIRIA published in 1983 [17][33][34][35][36]. The following **Table 1** presents the studies published on buildability in construction that refer to various definitions.

Table 1. Buildability studies and definitions.

Year of Publication and Reference		Publication Title	Major Focus	Definition Referenced
2012	[37]	Critical success factors to limit constructability issues on a net-zero energy home	Design & Construction	(CII, 1986)
2014	[38]	The evaluation of constructability towards construction safety	Design	(CII, 1986)
2015	[39]	Modelling a decision support tool for buildable and sustainable building envelope designs	Design	(CIRIA, 1983)
2017	[40]	AR (augmented reality) based 3D workspace modelling for quality assessment using as-built on-site conditions in remodeling construction project	Design & Construction	(CII, 1993)
2017	[41]	Beamless or beam-supported building floors: Is buildability knowledge the missing link to improving productivity?	Design	(CIRIA, 1983)
2018	[24]	Enhancing off-site manufacturing through early contractor involvement (ECI) in New Zealand	Early Design	(CIIA, 1992)
2019	[42]	Concepts of constructability for project construction in Indonesia	All Stages	(CII, 1986) (CIRIA, 1983)

Year of Publication and Reference		Publication Title	Major Focus	Definition Referenced
2019	[43]	An early-design stage assessment method based on constructability for building performance evaluation	Early Design	(CIRIA, 1983) (CII,1986)
2020	[44]	A systematic review of prerequisites for constructability implementation in infrastructure projects	Early Design & Design	(CIRIA, 1983) (CII, 1986)
2021	[27]	Constructability obstacles: An exploratory factor analysis approach	Design	(CII, 1986)
2022	[44]	Assessing design buildability through virtual reality from the perspective of construction students	Design	(CIRIA, 1983)
2022	[17]	Buildability in the construction industry: A systematic review	N/A	(CIRIA, 1983)
2023	[10]	Buildability attributes for improving the practice of construction management in Nigeria	Design & Construction	(CIRIA, 1983)
2023	[20]	Measures for improving the buildability of building designs in construction industry	Design	(CIRIA, 1983)

As per [11][14][26], three main constructs of buildability include: (01) “integrating construction knowledge and experience”, (02) “throughout the project delivery process” to (03) “achieve overall project objectives”, which are loosely focused on improving construction project performance. Agreeing with this, ref. [45] confirmed that only a little is known about the aspects that support the adoption and use of the buildability concept in construction.

Therefore, to properly integrate buildability, the main constructs need to be further decomposed to derive a practical methodology for its successful integration in construction. **Figure 2** above explains the deconstruction of the buildability concept following the widely used definitions.

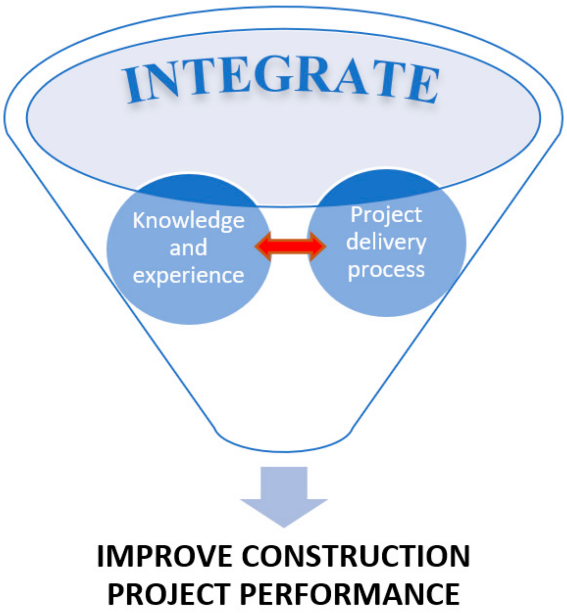

Figure 2. Key constructs of buildability.

5. Deconstruction of the Key Constructs of Buildability

Figure 2 illustrates that the concept of buildability is based on integrating knowledge and experience throughout the project delivery process, and is aimed at achieving the overall project objectives. Therefore, the “integration of construction knowledge and experience” is identified as the key driver within the buildability concept [26]. Ref. [46] described knowledge as “the individual capability to draw distinctions, within a domain of action, based on an appreciation of context or theory, or both”. There are two main types of knowledge: explicit knowledge and tacit knowledge [47]. Explicit knowledge, which is also known as “codified knowledge”, can be expressed in words and numbers and shared in the form of data, scientific formulae, specifications, manuals, and the like [48]. Tacit knowledge, on the other hand, is highly personal and embedded in individual experience [49]. Tacit knowledge therefore partly consists of technical skills that are hard to pin down [50]. Subjective insights, intuition, and hunches fall into this category of knowledge. For this reason, “tacit knowledge” is referred to interchangeably with “experience” [51][52] or “know-how” [50]. As per [52], the reference to tacit knowledge is context-specific. In this context, tacit knowledge is mainly acquired through industry practice and the experience of the practitioners.

Researchers agree that most knowledge in the construction sector is tacit rather than explicit [53]. Most tacit knowledge resides with people [54]. Therefore, people are the main source of knowledge in construction projects. People in construction projects include the project team members or the key stakeholders and the external stakeholders. Key stakeholders are the key source of knowledge in construction. Hence knowledge sharing between the key stakeholders is vital to incorporate buildability into construction projects [55].

Construction project stakeholders, as the key source of knowledge, come from various organizations and perform in a team to deliver the construction project [16][56]. Therefore, the construction project team is also referred to as a temporary multi-organization [57]. To manage the knowledge within an organization, people, technology, and well-designed processes are essential [58].

The next main construct of buildability refers to the project delivery process. In the majority of the studies, there is a consensus that the design stage is critical for implementing buildability [59][60][61]. However, CII in 1987 in their “Constructability Concept File” embraced all stages in building development for integration of construction knowledge, as each had its impact on achieving the overall project requirements. Similarly, many researchers criticized limiting buildability only to the design stage and argued that improvement measures were to be carried out throughout the whole building process [47][62][63]. Therefore, all stages of construction projects must require knowledge integration in order to get maximum buildability into the construction project [44]. Thus, all the work stages in the construction project are identified as key phases for integrating knowledge. Achieving real integration of people, technology, and processes throughout entire project delivery stages is challenging, as the contributions of the team members (sources of knowledge) throughout the project delivery stages are influenced by the procurement method of the project. For example, procurement methods such as the Integrated Project Delivery (IPD) approach facilitate the integration of buildability naturally as collaboration among the stakeholders is enabled from the beginning itself and provides space for adapting modern technologies [64]. However, in procurement methods such as the traditional approach, buildability integration is difficult as this method naturally creates fragmentation among the stakeholders [65]. However, it has to be noted that the procurement method is decided irrespective of the concerns about buildability [66][67]. Therefore, this research focuses on buildability irrespective of the procurement method and attempts to derive key constructs that can provide guidelines for any construction project. Therefore, the selection of a suitable plan of work to capture the construction process is necessary. This plan of work has to identify the various stages in the construction process while being neutral about all the procurement methods. The RIBA Plan of Work 2020 addresses the work stages of all procurement methods as well as modern methods of construction or new drivers, such as sustainability and maintainability.

The main constructs identified in the initial research can be deconstructed as shown in **Figure 3** below.

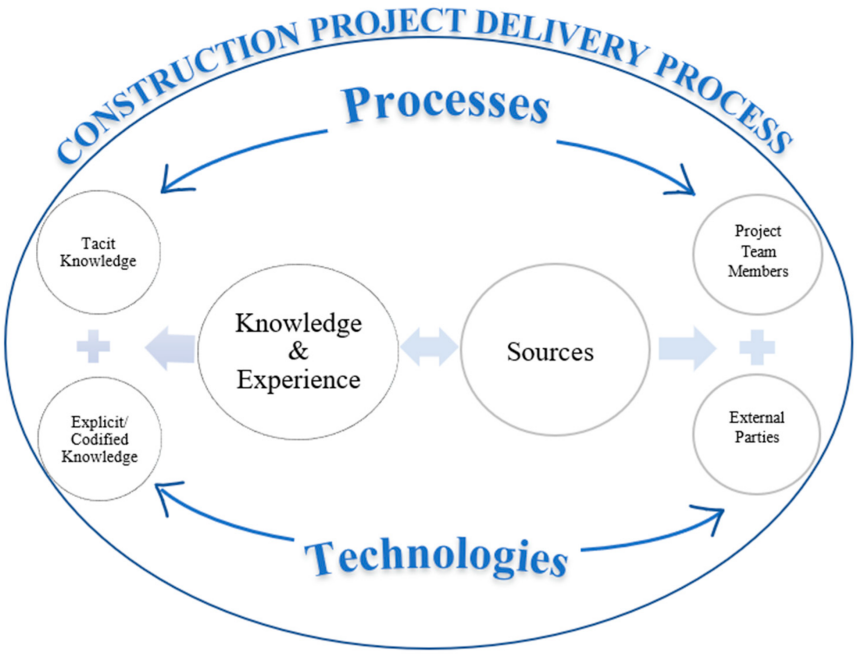

Figure 3. Deconstruction of the buildability concept.

References

1. Rathnayake, I.; Wedawatta, G.; Tezel, A. Smart Contracts in the Construction Industry: A Systematic Review. Buildings 2022, 12, 2082.
2. Masoetsa, T.G.; Ogunbayo, B.F.; Aigbavboa, C.O.; Awuzie, B.O. Assessing Construction Constraint Factors on Project Performance in the Construction Industry. Buildings 2022, 12, 1183.
3. Abal-Seqan, M.H.; Pokharel, S.; Naji, K.K. Key Success Factors and Their Impact on the Performance of Construction Projects: Case in Qatar. Sustainability 2023, 15, 3700.
4. Memon, A.H.; Memon, A.Q.; Khahro, S.H.; Javed, Y. Investigation of Project Delays: Towards a Sustainable Construction Industry. Sustainability 2023, 15, 1457.
5. Ogbu, C.P.; Adindu, C.C. Direct Risk Factors and Cost Performance of Road Projects in Developing Countries: Contractors' Perspective. J. Eng. Des. Technol. 2019, 18, 326–342.
6. Vilkonis, A.; Antucheviciene, J.; Kutut, V. Construction Contracts Quality Assessment from the Point of View of Contractor and Customer. Buildings 2023, 13, 1154.
7. Ashtari, M.A.; Ansari, R.; Hassannayebi, E.; Jeong, J. Cost Overrun Risk Assessment and Prediction in Construction Projects: A Bayesian Network Classifier Approach. Buildings 2022, 12, 1660.
8. Gebrehiwet, T.; Luo, H. Analysis of Delay Impact on Construction Project Based on RII and Correlation Coefficient: Empirical Study. Procedia Eng. 2017, 196, 366–374.
9. Kabirifar, K.; Mojtahedi, M. The Impact of Engineering, Procurement and Construction (EPC) Phases on Project Performance: A Case of Large-Scale Residential Construction Project. Buildings 2019, 9, 15.
10. Osuizugbo, I.C.; Oshodi, O.S. Buildability Attributes for Improving the Practice of Construction Management in Nigeria. Built Environ. Proj. Asset Manag. 2023, 13, 270–289.
11. CIRIA Buildability: An Assessment; Construction Industry Research and Information Association: London, UK, 1983.
12. Adams, S. Practical Buildability; Butterworths: London, UK, 1989.
13. CIIA. Research Report 1—The Development of Constructability Principles for the Australian Construction Industry; Construction Industry Institute: Adelaide, Australia, 1996; ISBN 1876189010.
14. Construction Industry Institute (CII). Buildability: A Primer; University of Texas: Austin, TX, USA, 1986.
15. Nima, M.A.; Abdul-Kadir, M.R.; Jaafar, M.S.; Alghulami, R.G. Constructability Implementation: A Survey in the Malaysian Construction Industry. Constr. Manag. Econ. 2001, 19, 819–829.
16. Kifokeris, D.; Xenidis, Y. Constructability: Outline of Past, Present, and Future Research. J. Constr. Eng. Manag. 2017, 143, 04017035.

17. Osuizugbo, I.C.; Okolie, K.C.; Oshodi, O.S.; Oyeyipo, O.O. Buildability in the Construction Industry: A Systematic Review. Constr. Innov. 2022; ahead-of-print.
18. Wimalaratne, P.L.I.; Kulatunga, U. A Methodology to Study the Complexity of Buildability In Construction Projects. In Proceedings of the 10th World Construction Symposium, Moratuwa, Sri Lanka, 24–26 June 2022; pp. 24–26.
19. Kalsaas, B.T.; Hannås, G.; Frislie, G.; Skaar, J. Transformation from Design-Bid-Build to Design-Build Contracts in Road Construction. In Proceedings of the 26th Annual Conference of the International Group for Lean Construction (IGLC), Chennai, India, 16–22 July 2018; Volume 1, pp. 34–45.
20. Samimpey, R.; Saghatforoush, E. A systematic review of prerequisites for constructability implementation in infrastructure projects. Civ. Eng. J. 2020, 6, 576–590.
21. Ding, C.S.; Salleh, H.; Kho, M.Y. Critical Constructability Principles for Girder Bridge Construction in Malaysia. Int. J. Sustain. Constr. Eng. Technol. 2019, 10, 41–51.
22. Finnie, D.; Ali, N.A.; Park, K. Design Development Post Contract Signing in New Zealand: Client's or Contractor's Cost? Proc. Inst. Civ. Eng. Manag. Procure. Law 2019, 172, 146–156.
23. Wong, F.W.H.; Lam, P.T.I.; Chan, E.H.W.; Shen, L.Y. A Study of Measures to Improve Constructability. Int. J. Qual. Reliab. Manag. 2007, 24, 586–601.
24. Finnie, D.; Ali, N.A.; Park, K. Enhancing Off-Site Manufacturing through Early Contractor Involvement (ECI) in New Zealand. Proc. Inst. Civ. Eng. Manag. Procure. Law 2018, 171, 176–185.
25. BCA. Code of Practice on Buildability 2022 Edition; Building and Construction Authority: Singapore, 2022.
26. Wimalaratne, P.L.I.; Kulatunga, U.; Gajendran, T. Comparison between the Terms Constructability and Buildability: A Systematic Literature Review. In Proceedings of the 9th World Construction Symposium, Moratuwa, Sri Lanka, 9–10 July 2021; pp. 196–207.
27. JadidAlEslami, S.; Saghatforoush, E.; Ravasan, A.Z. Constructability Obstacles: An Exploratory Factor Analysis Approach. Int. J. Constr. Manag. 2021, 21, 312–325.
28. Emmerson, H. Survey of Problems before the Construction Industries, A Report Prepared for the Ministry of Works; HMSO: London, UK, 1962.
29. Banwell, H. The Placing and Management Ofcontracts for Building and Civil Engineering Work; HMSO: London, UK, 1964.
30. Illingworth, J.R. Buildability—Tomorrow's Need. Build. Technol. Manag. 1984, 16–19.
31. Ferguson, I. Buildability in Practice; Batsford: London, UK, 1989.
32. Moore, D. Buildability Assessment and the Development of an Automated Design Aid for Managing the Transfer of Construction Process Knowledge. Eng. Constr. Archit. Manag. 1996, 3, 29–46.
33. Wong, F.W.H.; De Saram, D.D.; Lam, P.T.I.; Chan, D.W.M. A Compendium of Buildability Issues from the Viewpoints of Construction Practitioners. Archit. Sci. Rev. 2006, 49, 81–90.
34. Osuizugbo, I.C. The Need for and Benefits of Buildability Analysis: Nigeria as a Case Study. J. Eng. Des. Technol. 2020, 19, 1207–1230.
35. Jarkas, A.M. Analysis and Measurement of Buildability Factors Affecting Edge Formwork Labour Productivity Engineering Science and Technology Review. J. Eng. Sci. Technol. Rev. 2010, 3, 142–150.
36. Aina, O.O.A.; Wahab, A.B. An Assessment of Build Ability Problems In The Nigerian Construction Industry. Glob. J. Res. Eng. 2011, 11, 42–52.
37. Aktas, C.B.; Ryan, K.C.; Sweriduk, M.E.; Bilec, M.M. Critical Success Factors to Limit Constructability Issues on a Net-Zero Energy Home. J. Green Build. 2012, 7, 100–115.
38. Yustisia, H. The Evaluation of Constructability towards Construction Safety (Case Study: Kelok-9 Bridge Project, West Sumatera). Proc. Procedia Eng. 2014, 95, 552–559.
39. Singhaputtangkul, N.; Low, S.P. Modeling a Decision Support Tool for Buildable and Sustainable Building Envelope Designs. Buildings 2015, 5, 521–535.
40. Lee, S.Y.; Kwon, S.W.; Ko, T.K. AR(Augmented Reality) Based 3D Workspace Modeling for Quality Assessment Using as-Built on-Site Condition in Remodeling Construction Project. In Proceedings of the ISARC 2017—34th International Symposium on Automation and Robotics in Construction, Taipei, Taiwan, 28 June–1 July 2017; International Association for Automation and Robotics in Construction I.A.A.R.C.: Edinburgh, UK, 2017; pp. 181–188.
41. Jarkas, A.M. Beamless or Beam-Supported Building Floors: Is Buildability Knowledge the Missing Link to Improving Productivity? Eng. Constr. Archit. Manag. 2017, 24, 537–552.

42. Ansyorie, M.M.A. Concepts of Constructability for Project Construction in Indonesia. In Proceedings of the IOP Conference Series: Materials Science and Engineering, Malang, East Java, Indonesia, 4–6 September 2019; Institute of Physics Publishing: Bristol, UK, 2019; Volume 669, p. 012062.
43. Contrada, F.; Kindinis, A.; Caron, J.-F.; Gobin, C. An Early-Design Stage Assessment Method Based on Constructibility for Building Performance Evaluation. IOP Conf. Ser. Mater. Sci. Eng. 2019, 609, 072070.
44. Samarasinghe, D.A.S.; Piri, I.S. Assessing Design Buildability through Virtual Reality from the Perspective of Construction Students. Built Environ. Proj. Asset Manag. 2022, 12, 823–836.
45. Osuizugbo, I.C. Measures for Improving the Buildability of Building Designs in Construction Industry. Constr. Innov. 2023; ahead-of-print.
46. Osuizugbo, I.C.; Okolie, K.C.; Oshodi, O.S. Factors Supporting the Implementation of Buildability Assessment as a Tool for Buildability Improvement. J. Eng. Des. Technol. 2022; ahead-of-print.
47. Tsoukas, H.; Vladimirou, E. What Is Organizational Knowledge? J. Manag. Stud. 2001, 38, 972–993.
48. Nonaka, I.; Von Krogh, G.; Voelpel, S. Organizational Knowledge Creation Theory: Evolutionary Paths and Future Advances. Organ. Stud. 2006, 27, 1179–1208.
49. Hoe, S.L.; McShane, S. Structural and Informal Knowledge Acquisition and Dissemination in Organizational Learning: An Exploratory Analysis. Learn. Organ. 2010, 17, 364–386.
50. Nonaka, I.; Takeuchi, H. The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation; Oxford University Press: New York, NY, USA, 1995; ISBN 0195092694.
51. Nonaka, I. The Knowledge-Creating Company. Harv. Bus. Rev. 2007, 85, 162–171.
52. Eslami, M.H.; Lakemond, N.; Brusoni, S. The Dynamics of Knowledge Integration in Collaborative Product Development: Evidence from the Capital Goods Industry. Ind. Mark. Manag. 2018, 75, 146–159.
53. Hoe, S.L. Tacit Knowledge, Nonaka and Takeuchi Seci Model and Informal Knowledge Processes. Int. J. Organ. Theory Behav. 2006, 9, 490–502.
54. Zhao, N.; Ying, F.J.; Tookey, J. Knowledge Visualisation for Construction Procurement Decision-Making: A Process Innovation. Manag. Decis. 2021; ahead-of-print.
55. O'Meara, M.; Kelliher, F. Knowledge Codification. Knowl. Manag. Learn. Organ. 2021, 25–50.
56. Rahmani, F. Challenges and Opportunities in Adopting Early Contractor Involvement (ECI): Client's Perception. Archit. Eng. Des. Manag. 2020, 17, 67–76.
57. Wang, D.; Jia, J.; Jiang, S.; Liu, T.; Ma, G. How Team Voice Contributes to Construction Project Performance: The Mediating Role of Project Learning and Project Reflexivity. Buildings 2023, 13, 1599.
58. Sergeeva, N.; Roehrich, J.K. Temporary Multi-Organizations: Constructing Identities to Realize Performance Improvements. Ind. Mark. Manag. 2018, 75, 184–192.
59. Basten, D.; Haamann, T. Approaches for Organizational Learning: A Literature Review. SAGE Open 2018, 8.
60. Kesavan, M.; Gobidan, N.N.; Dissanayake, P.B.G. Analysis of Factors Contributing Civil Engineering Project Delays in Sri Lanka. In Proceedings of the 6th International Conference on Structural Engineering and Construction Management 2015, Kandy, Sri Lanka, 11–13 December 2015; pp. 40–46.
61. Latham, M. Constructing the Team: Joint Review of Procurement and Contractual Arrangements in the United Kingdom Construction Industry; HMSO: London, UK, 1994.
62. Low, S.P. Building and Sustainability Controls in Singapore: A Journey in Time. Procedia Eng. 2011, 20, 22–40.
63. Griffith, A.; Sidwell, A.C. Development of Constructability Concepts, Principles and Practices. Eng. Constr. Archit. Manag. 1997, 4, 295–310.
64. Dulaimi, M.F.; Ling, F.Y.Y.; Ofori, G. Engines for Change in Singapore's Construction Industry: An Industry View of Singapore's Construction 21 Report. Build. Environ. 2004, 39, 699–711.
65. Jadidoleslami, S.; Saghatforoush, E.; Heravi, A.; Preece, C. A Practical Framework to Facilitate Constructability Implementation Using the Integrated Project Delivery Approach: A Case Study. Int. J. Constr. Manag. 2019, 22, 1225–1239.
66. Laryea, S.; Samuel, L. Procurement Strategy and Outcomes of a New Universities Project in South Africa. Eng. Constr. Archit. Manag. 2019, 26, 2060–2083.
67. Wong, F.W.H.; Lam, P.T.I.; Shen, L.Y. A Dynamic Design Management System for Improving Buildability of Construction. Assoc. Res. Constr. Manag. 2004, 1, 1–3.